P.O. BOX 490 □ MARLTON, NEW JERSEY 08053 □ 609/767-6800 □ FAX: 609/767-3298

MODEL AM-5
AUTOMATIC MATCHING SYSTEMS

INSTRUCTION MANUAL

TABLE OF CONTENTS

SECTION I: DESCRIPTION

GENERAL

1.1 The Automatic Matching Network is designed to transform to the 50 ohms a wide range of resistance and reactive impedances that are encountered during a typical plasma operation. The network design is a basic "L" configuration having a shunt capacitor to handle the loading and a fixed coil and series capacitor to handle the tuning. Both capacitors are driven by servo motors which operate simultaneously and allow instantaneous tuning of the plasma. This tuning procedure is a complete "hands off" operation.

MECHANICAL

1.2 The equipment is housed in two seperate enclosures consisting of a Matching Network/Phase and Magnitude Detector and a Controller/Power Supply which are described as follows:

- The Matching Network is housed in an aluminum enclosure measuring 8 3/4" W x 5" H x 15" D. The Phase and Magnitude Detectors are contained in the Matching Network enclosure.

- The Controller/Power Supply is housed in an aluminum enclosure measuring 1 3/4" H x 8 1/2" W x 10" D, which contains the power supply and control circuitry for operating and controlling the servo motor system.

ELECTRICAL

Matching Network

1.3.1 The Matching Network assembly contains a variable air capacitor, a variable vacuum capacitor and a fixed coil connected in an "L" configuration. The "L" configuration is a widely accepted design because of its ability to allow wide range tuning. The variable capacitors are driven by servo motors.

Matching Network (continued)

An AUTO-MANUAL-REMOTE switch is provided on the front panel of the controller to select the mode of operation. When in the MANUAL position, momentary switches are provided for manually tuning the network. When in the AUTOMATIC position, the detectors control the speed and direction of travel of the servo motors. When in the REMOTE position an external 0-5 VDC signal controls the position of the motors. The RF input to the network is suppled by a rear mounted "N" panel connector. The RF output is available through a pair of "HN" connectors on the rear panel. There is also an input and output water fitting on the back panel. This is provided to reduce the temperature of the series coil, minimum water flow is 5 G.P.H.

Power Supply

1.3.2

The power supply is completely self-contained providing all necessary circuitry for controlling the servo motor system. The front panel contains the system status lights, TUNE/LOAD position meters and all control function switches. The rear of the power supply contains the Automatic Matching Network connector, the AC line connector and the remote control input/output connector. The power supply can operated from 115 VAC, 220 VAC or ±15 VDC @ 1.5 A power source.

Detectors

1.3.3

Both the PHASE and MAGNITUDE detectors are contained within the Matching Network. The PHASE detector controls the TUNING capacitor or series portion of the "L" network. The MAGNITUDE detector controls the shunt capacitor or LOAD portion of the "L" network. Both detectors operate

Detectors (continued)

simultaneously to transform the impedance of the load to maintain 50 ohms in the transmission line. In essence, when the detectors are sampling 50 ohms in the transmission line, the positive and negative error signals that the detector generates for driving the servo system should be virtually zero. The polarity of the error signal will determine the direction in which the servo motor will travel. This combined with the proper gain of the system will insure the proper tuning sequences.

DC Sample Network

1.3.4 A DC sample circuit is contained within the Matching Network to provide means to measure the developed DC voltage. (See Section VIII for connections and voltage input/output).

SECTION II CONTROLS AND INDICATORS

L.E.D'S

Fail

2.1.1 Indicates a loss of the reference voltage from controller to Matching Network.

- Limit

2.1.2 Motor has reached its maximum C.C.W. position.

+ Limit

2.1.3 Motor has reached its maximum C.W. position.

On

2.1.4 Indicates power applied to controller.

METERS

Tune/Load Meter

2.2 Indicates approximate position of TUNE/LOAD capacitor. 0 = minimum capacitance; 1 = maximum capacitance.

SWITCHES

+/- Switch

2.3.1 Allows capacitance to be increased (+) or decreased (-) in MANUAL mode only.

ON/OFF Switch

2.3.2 Applies power to controller.

Auto-Manual-Remote Switch

2.3.3 Determines mode of operation. In AUTO, controlling voltage is from Phase and Magnitude detectors. In MANUAL, controlling voltage is from +/- switches. In REMOTE, controlling voltage is from an external 0-5 VDC signal. With switch

Auto-Manual-Remote Switch (continued)

in REMOTE and a 0-5 VDC signal applied to J2-13 (Load) or J2-12 (Tune) with J2-2 (Load) or J2-5 (Tune) at ground, the TUNE/LOAD capacitor can be pre-set to any position. Removing the ground from J2-2 and J2-5 places the system in AUTO. Capacitor positioning is proportional to applied voltage.

0 VDC = minimum setting
5 VDC = maximum setting
2.5 VDC = 50 percent

J1: Control signals To/From Matching Network.
J2: Remote Input/Output signals.
J3/J4: Not used on AM-5.

(See Sections VI and VII for connections and voltage connections)

Phase/Magnitude Gain Adjust

2.3.4 Adjusts gain of servo loop.

SECTION III INSTALLATION

UNPACKING

3.1 Remove the AM-5 Automatic Tuning System from the carton and packing materials. Examine for visible damage. If any part of the system has been damaged notify both RF Plasma Products and the transportation company at once.

ELECTRICAL AND MECHANICAL CONNECTIONS

3.2 Mount the controller in a convenient rack panel and connect the interconnecting cable and line cord. Remove the cover of the Matching Network and inspect for any loose or broken components. Now connect the interconnecting cable to the jack labled AMPS-2A (P6) on the Matching Network. Before R.F. is applied a minimum flow of 5 G.P.H. of water is required by the Matching Network. With the AUTO-MANUAL-REMOTE switches in MANUAL operate the ± switches making sure the motors turn smoothly and that the limit L.E.D.'s and rotation meters operate. Connect the Matching Network (J3 RF output) to the chamber with a pair of "HN" connectors using RG-217 cable. Mount the Matching Network in position and replace the cover which may have been removed during inspection or mounting. A separate ground strap is required if network is not physically connected to chamber. Next, connect the RF input cable to the rear of the network (J2 RF input).

SECTION IV OPERATION

CONTROLS AND INDICATORS

4.1 If using an RF Plasma Products RF power supply, turn on the RF power supply to approximately 200 watts or until you have established a plasma. Manually tune the network with the +/- switches on the controller. Once the network has been manually tuned then proceed to position the two toggle switches located on the front of the controller into AUTOMATIC. You will note that in the AUTOMATIC position, the reflected power should be at a minimum position and the forward power at a maximum position consistent with the output of the generator.

To make sure the detectors are tracking properly, switch the controller back into MANUAL and de-tune the Matching Network to approximately 100W reflected power and then flip the toggle switches back into AUTOMATIC. The reflected power should then go back to its original minimum position.

If the network does not seem to be performing in the manner described above, check "AM-5 Set-Up".

SECTION V AM-5 SET UP

5.1 Check that all connections are properly made. Also, check that there is a good ground between chamber, Matching Network, and controller before proceeding. The Matching Network cover must be in place before attempting to null PHASE and MAGNITUDE pots. If network will not tune in MANUAL, try removing one or more of the 200pf ceramic capacitors across A1C1 (Magnitude/Load Capacitor). In some cases it may be necessary to change the number of active turns, (change tap) on the series coil to achieve the best match.

If unit tunes manually but goes out of match in "AUTO", manually retune unit for best match, then place tune in AUTO and with Load still in MANUAL adjust PHASE adjust pot on back of Matching Network for a null in Reflected power. After this is done, place Load in AUTO and tune in MANUAL and adjust MAGNITUDE adjust pot for a null in Reflected power.

After this is done place both TUNE and LOAD switches in AUTO and slightly readjust PHASE and MAGNITUDE adjust pots to improve match if possible.

If motors run to one end before adjustment can be made, manually return to position that gave match originally, then repeat adjustment. In some cases it may help by placing the 10 turn PHASE and MAGNITUDE adjustment pots to the center of their range. If motors "HUNT", try reducing the gain of the PHASE or MAGNITUDE circuit on the back of the controller. C.W. decreases gain. C.C.W. increases gain.

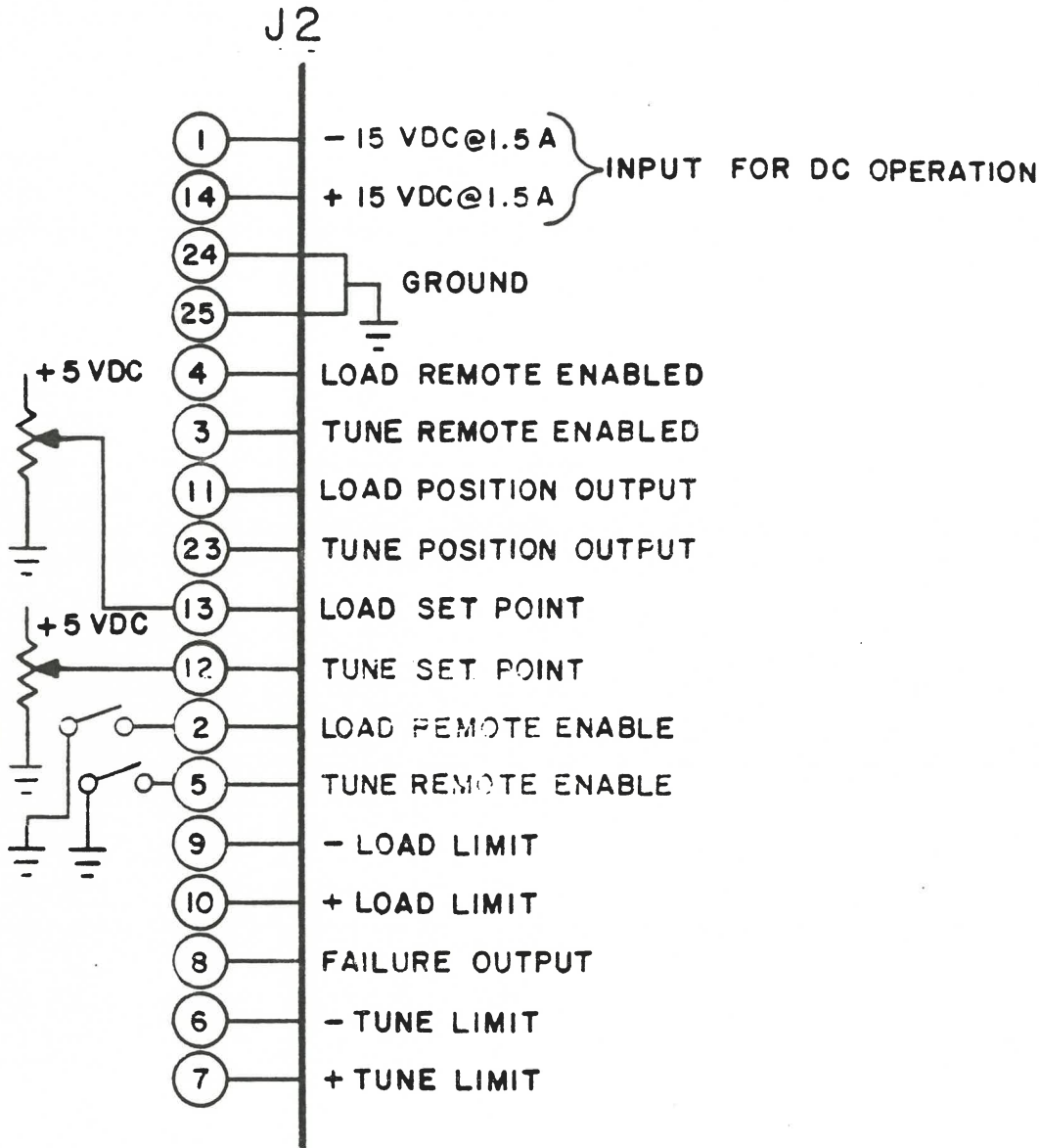
If unit is not sensitive enough to a mismatch, try increasing the gain of the PHASE or MAGNITUDE circuit.

SECTION VI REMOTE FUNCTIONS

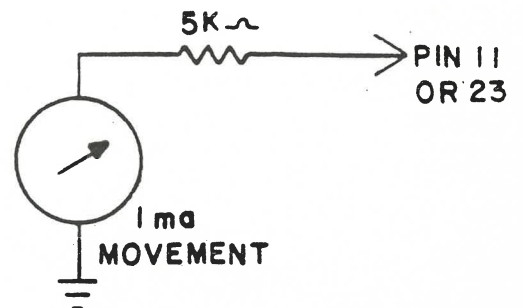
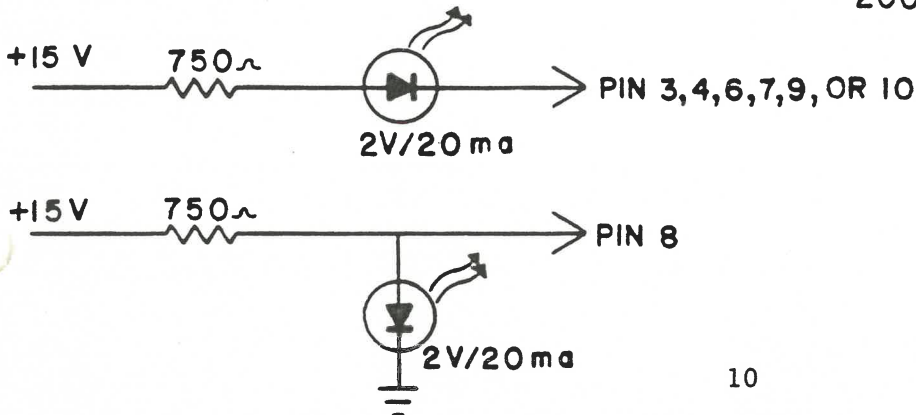
J2 Pin		
1	-15 VDC Input	(for D.C. operation)
2	Remote ON/OFF (Load)	(ground to Enable)
3	Remote ON (Tune)	(Low when in Remote)
4	Remote ON (Load)	(Low when in Remote)
5	Remote ON/OFF (Tune)	(ground to Enable)
6	- Tune Limit	(Low at - Limit)
7	+ Tune Limit	(Low at + Limit)
8	Failure output	(Low in normal operation/ High with a failure)
9	- Load Limit	(Low at - Limit)
10	+ Load Limit	(low at + Limit)
11	Load Meter output	(0-5 VDC output proportional to Front panel meter)
12	Set point input (Tune)	(0-5 VDC input used to position capacitor in Remote)
13	Set point input (Load)	(0-5 VDC input used to position capacitor in Remote)
14	+15 VDC input	(for D.C. operation)
15-22	Not Used	
23	Tune Meter output	(0-5 VDC output proportional to Front panel meter)
24	Ground	
25	Ground	

SECTION VII: REMOTE CONTROL CONNECTIONS

J2

Pin	Function
1	− 15 VDC@1.5 A (INPUT FOR DC OPERATION)
14	+ 15 VDC@1.5 A (INPUT FOR DC OPERATION)
24	GROUND
25	GROUND
4	LOAD REMOTE ENABLED
3	TUNE REMOTE ENABLED
11	LOAD POSITION OUTPUT
23	TUNE POSITION OUTPUT
13	LOAD SET POINT
12	TUNE SET POINT
2	LOAD REMOTE ENABLE
5	TUNE REMOTE ENABLE
9	− LOAD LIMIT
10	+ LOAD LIMIT
8	FAILURE OUTPUT
6	− TUNE LIMIT
7	+ TUNE LIMIT

+5 VDC

+5 VDC

TYPICAL CONNECTIONS

SECTION VIII DC SAMPLE CONNECTIONS

P7 Pin	
1	+15 VDC input @ 10 mA
2	-15 VDC input @ 10 mA
3	No Connection
4-5	Ground
6-7	No Connection
8-9	DC output, Reference to ground (Pins 4-5)

8.1 Voltage output verses voltage input to DC Sample Network. (Approximately 1K ohm Load from Pins 8-9 to ground. 1000V RF P-P in DC Sampler input).

Developed DC	DC Sampler Output (±2% Accuracy)
-50V	+.25V
-100V	+.50V
-150V	+.75V
-200V	+1.00V
-250V	+1.25V
-300V	+1.50V
-400V	+2.00V
-500V	+2.50V
-600V	+3.00V
-700V	+3.50V
-800V	+4.50V
-1000V	+5.00V

SECTION IX ALTERNATE POWER SUPPLIES

115 VOLT OPERATION

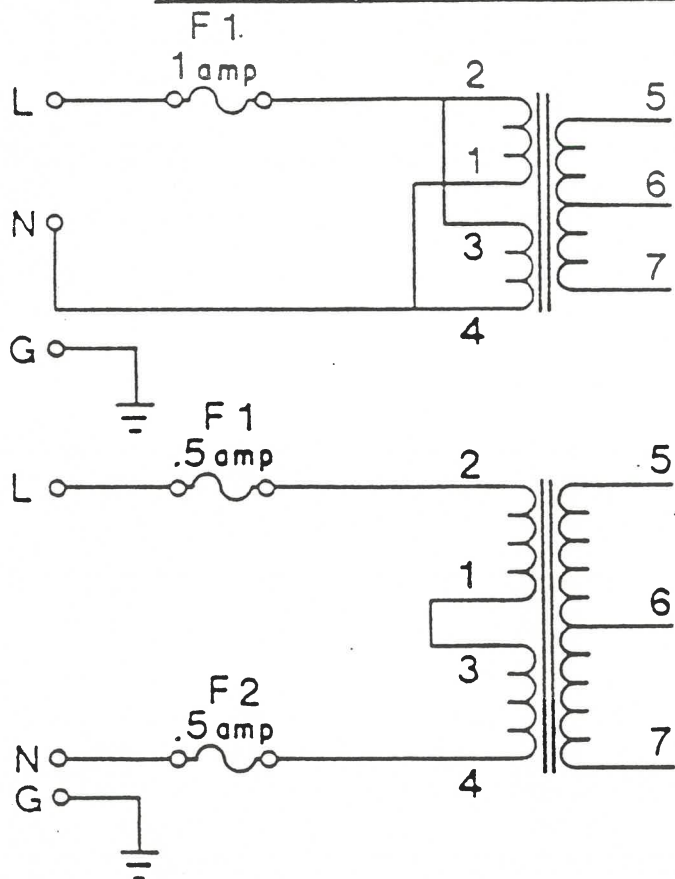
9.1 Connect 2 to 3 and 1 to 4 on Transformer T1 Primary. S1 on PC Board must be in position C2. Fuse should be 1 Amp slow blow.

220 VOLT OPERATION

9.2 Neutral (white) line from the AC Input Jack must be run through the second fuse holder. Both fuses will be 0.5 Amp slow blow. S1 must be in position C2. Connect 1 to 3 on Transformer T1 Primary.

±15 VOLT DC OPERATION

9.3 Place S1 to position C1. Apply -15VDC @ 1.5A to J2, Pin 1. Apply +15VDC @ 1.5A to J2, Pin 14. Ground goes to Pins 24 and 25 on J2. Check for +15 Volts on + lead of C10. Check for -15 Volts on - lead of C9 after making the proper change.

OPTIONAL LINE VOLTAGE SCHEMATICS

SECTION X TECHNICAL SPECIFICATIONS

ELECTRICAL

Detectors	
Frequency Range	13.56 MHz (27.12 MHz Custom Basis)
Power Handling	500 Watt continuous
Impedance	50 ohms
VSWR Introduced	Less than 1.1-1
Tuning Network	
Frequency Range	13.56 MHZ (27.12 MHz Custom Basis)
Power Handling	500 Watt continuous
Input Impedance	50 ohms
Output Impedance	Wide range

ELECTRICAL

Power Requirements	220/115 VAC 50/60 Hz ±15VDC @ 1.5A
Power Consumption	45 W Maximum

MECHANICAL

Power Supply	
Height	1 3/4"
Width	8 1/2" (19" rack mount)
Depth	10"
Tuning Network	
Height	5"
Width	8 3/4"
Depth	15"

SECTION XI   RECOMMENDED SPARE PARTS LIST

11.1 CONTROLLER

NOMENCLATURE	DESCRIPTION	PART NUMBER
BR1	Bridge Rectifier MDA970-1	48100007
C9, C10	Electrolytic Capacitor 4700MFD @ 35V	15050035
Q1, Q3	Power Transistor T1P41	48040034
Q2, Q4	Power Transistor T1P42	48040035
R30, R33	Pot. 500 ohms Bourns #3299W-1-501	47100050
R53, R58	Pot. 500K ohms Bourns #3299X-1-504	47100053
R65, 70, 78, 83	Pot. 1K ohm Bourns #3299W-1-102	47100051
U1, 2, 9, 10	IC LM 324N	48010011
U3, 4, 7	IC LM 339N	48010021
U5, 6, 13, 14	IC CD4016B	48010019
U8	IC CD4011B	48010051
U11	IC CD4001	48010018
U12	IC CA3096AE	48010062
U15	IC LM358N	48010015
U16	IC CA3183E	48010060
U17	IC CA3141E	48010061
UR1	Voltage Regulator LM317T	48010012
UR2	Voltage Regulator LM337T	48010059
DS1-6	LED Red GE#CM5754	24040016
S1	Toggle Switch 4PDT	51020050
S2, S4	Toggle Switch SPDT	51020051
S3, S5	Toggle Switch SPDT	51020052
T1	Power Supply Transformer	56010120
F1	Fuse, 1 amp slo blo Little Fuse #313001	43080014

SECTION XI RECOMMENDED SPARE PARTS LIST (continued)

11.2 MATCHING NETWORK

NOMENCLATURE	DESCRIPTION	PART NUMBER
A1C1	Capacitor Air Variable Cardwell 154-33-1	15040013
A1C2-A1C5	Capacitor Ceramic 200pf @ 7.5KV	15190010
A1C6	Capacitor Variable Vacuum Jennings UCSL-500-5S	15020004
A1C7	Capacitor Ceramic 1000pf @ 5KV	15190006
J3	Connector Type "HN"	21020014
A5M1, A4M1	Motor Japanese Products #DME32BHP-12V	35010005
A5 Assembly	Gear Box Japanese Products #6H100	35030002
A4 Assembly	Gear Box Japanese Products #6H1800	35030001
A5R1	Pot. 1K ohm Bourns #35415-1-102	47100055
A4R1	Pot. 1K ohm Spectrol #132-0-0-102	47100054
A2CR1-A2CR4	Diode IN38A	48020003
A2C7, A2C8	Capacitor Ceramic 5pf @ 5KV	15190012
A2F1	Fuse .75 amp Little Fuse 318750	43030009
A2R1, A2R2	Pot. 20K Bourns #3299-X-203	47100019
A2U1	IC LM741	48010006
A2ZD1, A2ZD2	Diode Zener IN4743/13 volt	48020029

REV.	ZONE	DESCRIPTION	DATE	APPROVED
M		R6,22 WERE 5.1K/ECN 849 J1-15 GROUNDED ECN 842	6-25-91	E. Duenas
L		REVISED PER ECN Nº M4650	1-7-98	
K		REVISED PER ECN Nº 513C	7-8-86	J. PONIST
J		REVISED PER ECN Nº M2780	3-17-86	JP
I		REVISED PER ECN Nº M1740	11-5-85	J. PONIST
H		REVISED PER ECN Nº M1480T	6-3-85	JP
G		REVISED PER ECN Nº M0730	3-4-85	JP
F		REVISED PER ECN Nº M0640	1-16-85	JP
E		REVISED PER ECN Nº 712	6-9-84	JWP
D		REVISED PER ECN Nº 688	5-10-84	JWP
C		REVISED PER ECN Nº 637	2-20-84	HGF
B		RELEASED PER EPR Nº 014	12-9-84	RAH
A		PRELIMINARY RELEASE	10-14-83	RAH

NOTES:

1- Unless Otherwise Indicated, Resistance is in Ohms, 1/4 Watt Dissipation Rating, Fractional Values of Capacitance in Microfarads, All Others in Picofarads.

NO CONNECTION — CONNECTION

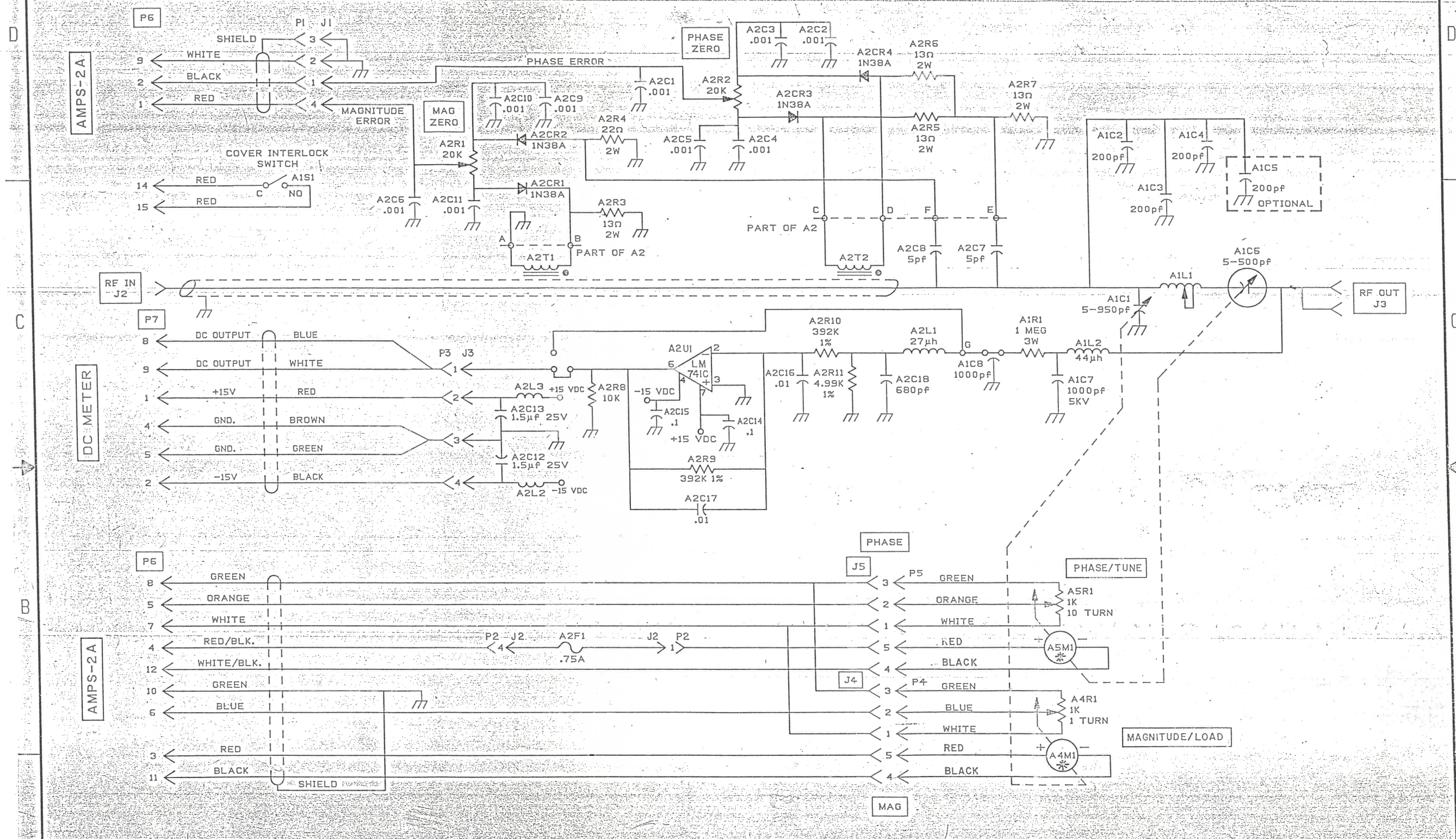
C38,130 — NEXT ASSY — USED ON — FIRST APPLICATION

DRAWN NAL DATE 10-14-83
ENG APPVL RAH DATE 10-14-83
REL TO PROD DATE
REF. TO EPL

RF Plasma Products, Inc.

TITLE: SCHEMATIC DIAGRAM MATCHING NETWORK CONTROLLER

DWG. NO. 40,247 — SHT 1 OF 1 — SCALE NONE — SIZE D

PT-D2

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E		REVISED PER ECN 795	4-4-91	RAO							
D		DELETED SHIELD - P3-3 / ECN M4850	3-21-88								
C		WAS AMN-502 / ECN M3170	11-11-86								
B		RELEASED PER EPR 6037	10/31/85								
A		PRELIMINARY	9/18/85		F		REVISED PER ECN 834	8/26/91	E.	B23,407-000	AM-5

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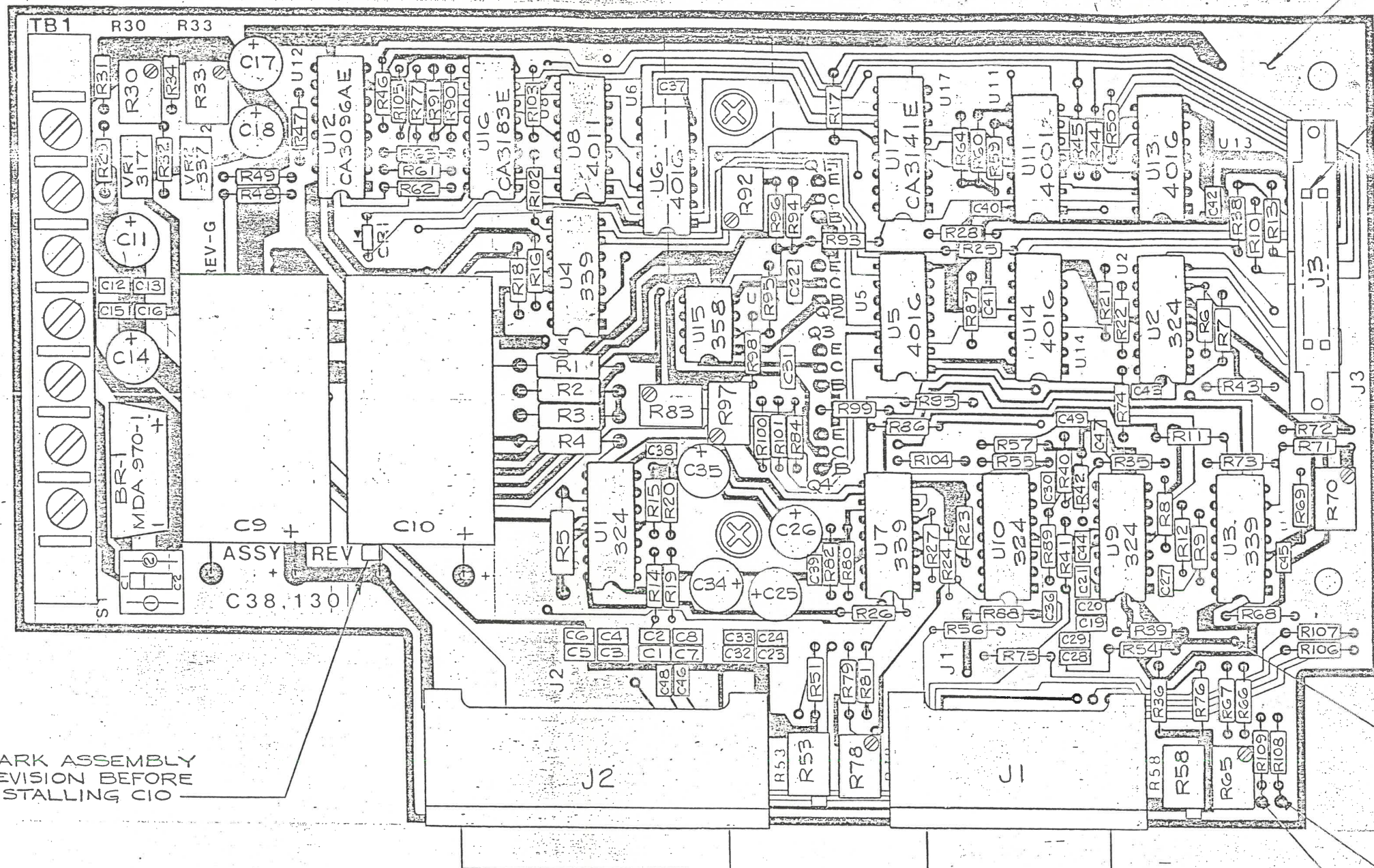
REVISIONS | FIRST APPLICATION

DRAWN BSR DATE 09/16/85
CHECKED DATE 9/18/85
ENG. APPVL. DATE 9/18/85
REL. TO PROD. DATE 11-1-85
USED ON AM-5

RF PLASMA PRODUCTS INC.
22 OLNEY AVENUE CHERRY HILL, NEW JERSEY 08003 (609)424-7500

TITLE SCHEMATIC DIAGRAM MATCHING NETWORK AM-5

DR. NO. 30,187 | SHEET 1 OF 1 | SCALE N/A | SIZE C

PIN 1
MARK ASSEMBLY
REVISION BEFORE
INSTALLING C10
C38,130
GND WIRE
FROM BACK
PANEL
C38,131
J4
J3
J1
J2
BOTTOM OF P.C.BD.
Q1 THRU Q4
SUPERCEDES 2303750501
DRAWN E D RAINIER 11-2-83
ENG APPVL RAH 12-5-83
REL TO PROD
REF. TO EPL
Plasma-Therm, Inc.
TITLE P.C.ASSEMBLY
POWER SUPPLY
MATCHING NETWORK CONTROL
DWG. NO. 38,130
SHT 1 OF 1
SCALE 2:1
SIZE C
C38,131
NEXT ASSY
USED ON
FIRST APPLICATION
G REVISED & REDRAWN ECN 3000
REV. ZONE DESCRIPTION DATE APPROVED
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PT-C2

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
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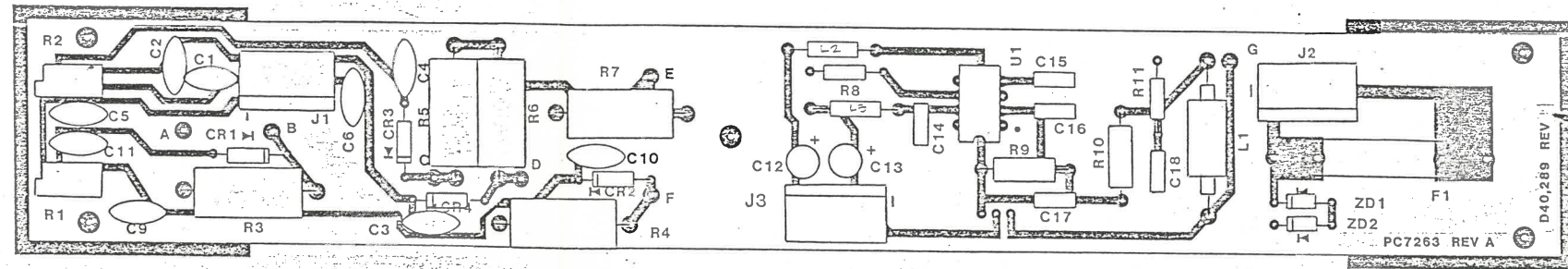
PRODUCTION TO MARK ASSEMBLY REVISION LETTER WITH PERMANENT BLACK INK

REF: EPL - 323 407 - 002
USED ON: AM-5

4th GENERATION 4 PHEASANT RUN • NEWTOWN, PA 1894[illegible]

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE FRACTIONS DECIMALS ANGLES .XX .XXX	CONTRACT NO 85369		CUSTOMER: RF PLASMA
MATERIAL	APPROVALS	DATE	BOARD TITLE: AM-5 MATCHING NETWOR[illegible] PCB ASSEMBLY DRAWING
	DRAWN BAVLZ	5 24 85	
FINISH	CHECKED B. Ems	5/24/85	SIZE D · FSCM NO. 62116 · DWG. NO. D40,289 · REV A
	ISSUED		
DO NOT SCALE DRAWING			SCALE 2:1 · SHEET 1/1

REVISIONS
REV | ZONE | DESCRIPTION | DATE | APPROVED
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B | ADDED TABULATION "A" CHANGED DETAIL B
C | WAS AMN-502 / ECN M3170
SEE DETAIL A
INSTALL WITH 38
2 PLACES
25 39 40 12 PLACES
23 2 PLACES
16A 16 SEE TABULATION "A"
27 41 42 26
COOLING WATER
OUT
IN
J3 RF OUTPUT
AM-5
P6 AMPS 2A
PHASE ZERO
MAG ZERO
J2 RF INPUT
SEE DETAIL C
SEE DETAIL B
INSTALL WITH 45 2 PLACES
26 3 PLACES
PART | ASSEMBLY USAGE
001 | 4N CONNECTOR
002 | C CONNECTOR
TABULATION "A"
25 39 40 5 PLACES
29 42 41 53
LOOSEN THESE ITEMS TO ALLOW INSERTION OF ITEM 33. RETIGHTEN ITEMS 35, 44 & 51. (4 PLACES)
34 43 4 PLACES
35 44 51
MAG/LOAD
PHASE/TUNE
J4 -MAG
J5-PHASE
P7- DC METER
P1 J1
P3 J3
P2 J2
25 39 40 2 PLACES
33 4 PLACES
UNLESS OTHERWISE SPECIFIED THE SURF. FIN. OF MACHINED PARTS SHALL NOT EXCEED A MAX READING OF 125/PER
AMERICAN STD • B46.1 • 1962
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING
TOLERANCES ON:
BASIC DIMENSIONS | 2 PLACE DECIMALS | 3 PLACE DECIMALS
UP TO 6 | ±.02 | ±.005
ABOVE 6 TO 24 | ±.03 | ±.010
ABOVE 24 | ±.06 | ±.015
ANGULAR DIMENSIONS ± 1/2°
DRAWN 4TH GEN B.A.V.L. III 5-28-85
CHECKED
ENG. APPVL
REL TO PROD
RF Plasma Products, Inc
22 OLNEY AVENUE CHERRY HILL, NEW JERSEY 08003 609/424-7500
TITLE TOP ASSEMBLY AM-5
SIZE D NO. D44478
SCALE
WEIGHT
SHEET 1 OF 2
B23407-000 AM-5
NEXT ASSY
USED ON
FIRST APPLICATION
MFG. SPEC. NO.
DASH NO. | MATERIAL | FINISH | SPEC.
LIST OF SPECIFICATIONS
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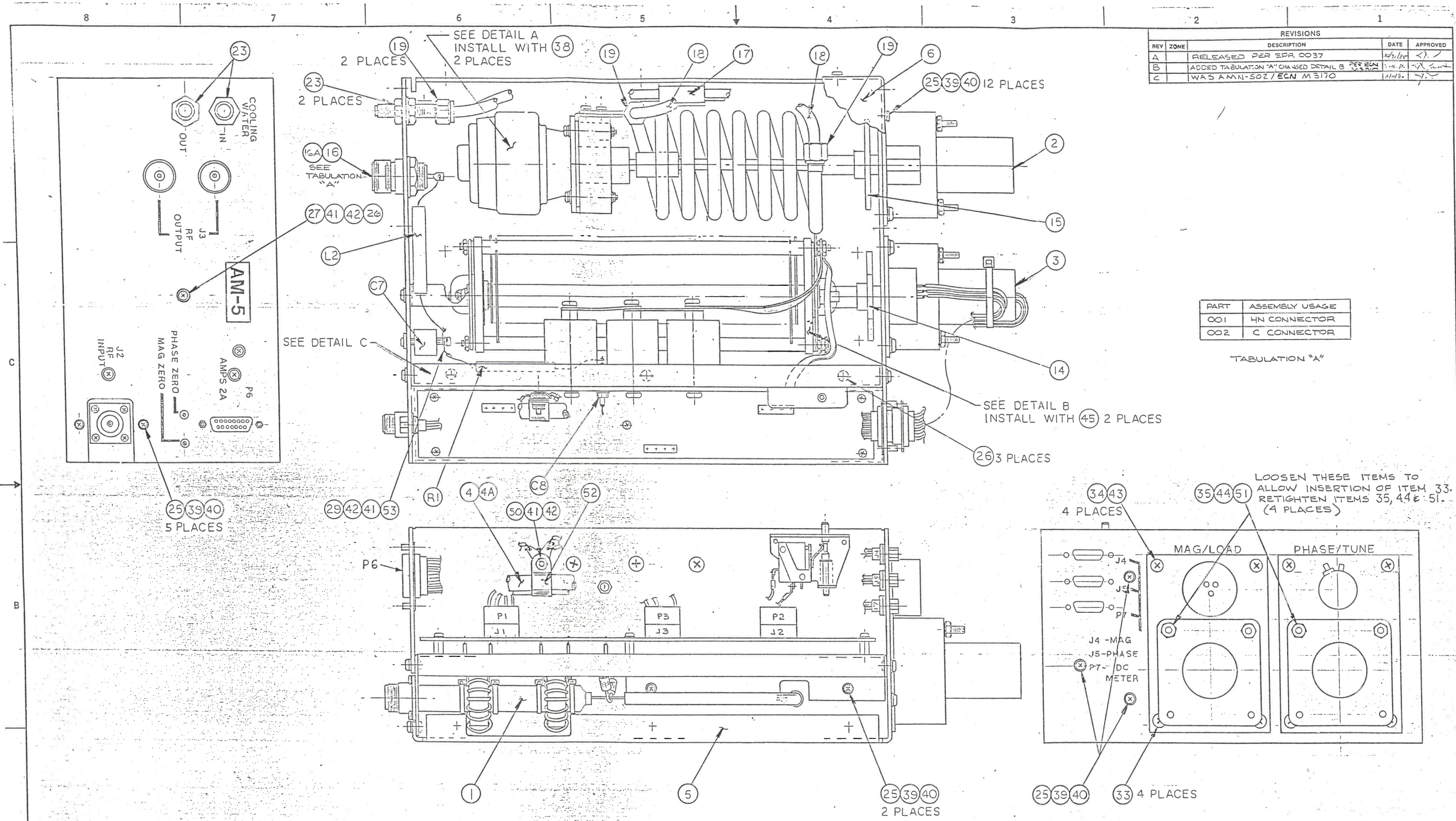
REVISIONS
REV
ZONE
DESCRIPTION
DATE
APPROVED
TYP 2 PLACES
TYP 3 PLACES
6 PLACES
WATER COOL-COIL (REF)
RF INPUT LINE (REF)
TYP 2 PLACES
2 PLACES
REF
DETAIL A
DETAIL B
3 PLACES
3 PLACES
2 PLACES
SEE SHEET I
DETAIL C
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING
AMERICAN STD • B46.1 • 1962
ANGULAR DIMENSIONS ± 1/2°
MFG. SPEC. NO.
NEXT ASSY
USED ON
FIRST APPLICATION
DRAWN
CHECKED
ENG. APPVL
REL TO PROD
DATE
RF Plasma Products, Inc
22 OLNEY AVENUE CHERRY HILL, NEW JERSEY 08003 609/424-7500
TITLE
SIZE
D
NO.
D44 478
SCALE
WEIGHT
SHEET 2 OF 2
LIST OF SPECIFICATIONS
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D ±.50
12.00 FT.
AM CONTROLLER
P1
OUT
AMN PS2A
ALPHA 5582
ALPHA 5582
AM-5,10,20
P6
MATCHING NETWORK
P1 P6
1 BLACK 1
2 BROWN 2
3 RED 3
4 ORANGE 4
5 YELLOW 5
6 WHITE 6
7 BLUE 7
8 VIOLET 8
9 GRAY 9
10 GREEN 10
11 WHITE / BLACK 11
12 WHITE / BROWN 12
13 SHIELD DRAIN WIRE
P7 P6
1 RED 14
3 RED 15
TWISTED WIRE
INTERLOCK
OVERALL LENGTH EXTENDING FROM P6 6 IN.
SUPERCEDES DWG # 2203849501
E
ADDED LABELS ECN 6960
4-23-90
REV.
ZONE
DESCRIPTION
DATE
APPROVED
200785650X
AM 10/20
NEXT ASSY
USED ON
FIRST APPLICATION
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DRAWN DATE
R. MEROLA 10-31-85
ENG APPVL DATE 11-1-85
REL TO PROD DATE 11-1-85
REF. TO EPL
B23,407-008
Plasma-Therm, Inc.
TITLE
ASSEMBLY, INTERCONNECT CABLE, AM CONTROLLER-AM-5/10/20
DWG. NO.
28,138
SHT 1 OF 1
SCALE
SIZE
B